PATENT ABSTRACTS OF JAPAN

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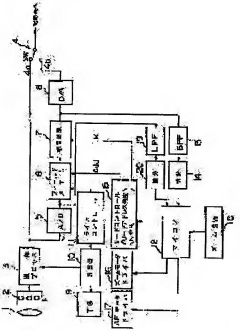
(54) AUTOMATIC FOCUSING SYSTEM



(57)Abstract:

PURPOSE: To attain a high speed and high precise automatic focusing by detecting a scanning direction in which a suitable contrast information can be obtained, and using information related with high-pass components in a video signal obtained by scanning the direction as a focusing evaluation value.

CONSTITUTION: A luminance signal Y from an image pickup processing circuit 3 is written through an A/D converter 5 in a field memory 6, and supplied through a BPF 19 and an integration circuit 20 to a microcomputer(MC) 12 as automatic exposure adjustment(AE) information. Next, the video signal which is rotated at an angle at which the suitable contrast based on the AE information can be obtained is read from the memory 6 by the control of a read control circuit 15. The video signal is interpolated by an interpolation coefficient K by an interpolation processing circuit 7, and supplied through a BPF 13 and an integration circuit 14 to the MC 12 as the evaluation value indicating a focusing level. The MC 12 drives an AF motor driver 17 based on the evaluation value, and allows it to operate a focusing operation.

CLAIMS

[Claim(s)]
An automatic focus method comprising using information concerning a high-frequency component in a video signal corresponding to a focus object domain as focusing evaluation value:
An effective scanning direction recognition means for recognizing information concerning whether it is what can extract contrast information effectively [when a gestalt of an image in the focus object domain scans in what kind of direction] based on a distribution state of photometry information which starts the focus object domain concerned at least.
An automatic focus means for performing focusing adjustment operation using information concerning a high-frequency component in video information which scanned and obtained the above-mentioned focus object domain at least in the direction effectually recognized by the above-mentioned effective scanning direction recognition means as focusing evaluation value.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the automatic focus method which makes possible a high-speed and highly precise automatic focus especially to any photographic subjects about an automatic focus method.
[0002]
[Description of the Prior Art]In recent years, the art of performing an automatic focus (AF), automatic exposure adjustment (AE), an automatic white balance (AWB), etc. by digital processing based on the video signal obtained from the imager without using a special sensor gains popularity. An automatic focus method is a method which carries out drive controlling of the motor for AF so that it may use as an evaluation value which shows the degree of the focus by the value obtained by carrying out digital integration of the high-frequency component of the video signal in a focus object domain and this evaluation value may serve as the maximum. Extraction of the high-frequency component of a video signal is performed using a band pass filter.
[0003]Thus, the conventional automatic focusing control is performed based on the integral value of the high-frequency component of the video signal obtained from the imager. However, in this automatic focus method, since it is what extracts the high-frequency component of the video signal of a horizontal pixel direction, when a photographic subject is a vertical bar, the high-frequency component of a high level is acquired, but. A high-frequency component level falls at the time of a slanting line, in the case of a horizontal line, a high-frequency component is not acquired, and highly precise controls focusing cannot be performed. For example, when a photographic subject is the vertical bar A shown in drawing 16, the video signal obtained from an imager becomes steep [falling and a standup], as shown in A1 of drawing 17 (A), and the signal after band pass filter passage also serves as a high level like A2. However, since an imager output serves as a gently-sloping change, without a level variation becoming steep like B1 of drawing 17 (B) when a photographic subject is a slash like B of drawing 16, the signal level after band pass filter passage will fall, and focusing precision will fall. An imager output serves as only a dc component and an output stops appearing in a van path filter like drawing 17 (C) in a horizontal line photographic subject like C of drawing 16.
[0004]

[Problem(s) to be Solved by the Invention]As mentioned above, the conventional automatic focus method cannot perform highly precise controls focusing, when a photographic subject is close to a slash or a horizontal line. Although it is solvable by constituting the bunt path filter for high-frequency component extraction from a vertical filter, obtaining a steep level variation like D1 of drawing 16 to a horizontal line photographic subject, and obtaining a high level like D2 as a band pass filter output, In that case, since 1H delay means is needed, a circuitry scale not only becomes large, but the problem that it cannot respond to a slash photographic subject arises. The art in which only an optimal angle rotates the whole optical system to a slash or a horizontal line photographic subject is proposed, and (JP,58-708,B) the mechanism part for rotation of an optical system also produces complexity and the problem of enlarging.

[0005]Then, the purpose of this invention is to provide the automatic focus method which makes possible a high-speed and highly precise automatic focus to any photographic subjects including a horizontal line and the shape of a slash.

[0006]

[Means for Solving the Problem]In order to solve the above-mentioned technical problem, an automatic focus method by this invention, It is an automatic focus method using information concerning a high-frequency component in a video signal corresponding to a focus object domain as focusing evaluation value, Based on a distribution state of photometry information which starts the focus object domain concerned at least, An effective scanning direction recognition means for recognizing information concerning whether it is what can extract contrast information effectively [when a gestalt of an image in the focus object domain scans in what kind of direction], It has an automatic focus means for performing focusing adjustment operation using information concerning a high-frequency component in video information which scanned and obtained the above-mentioned focus object domain at least in the direction effectually recognized by the above-mentioned effective scanning direction recognition means as focusing evaluation value, and is constituted.

[0007]

[Function]In this invention, the high-speed and highly precise automatic focus is made possible by using the information concerning the high-frequency component in the video information acquired by detecting the scanning direction where suitable contrast information is acquired, and scanning it in the detected direction as focusing evaluation value.

[0008]

[Example]Next, it explains in detail, referring to drawings for the example of this invention. Drawing 1 is a block diagram showing one example of the automatic focus method by this invention. This example rotates an object image video signal with inclination to an optimal angle (lengthwise direction) electrically, and enables always highly precise high-frequency component extraction. for example, suitable in the original picture shown in drawing 2 (A) -- angle rotation is carried out and image [of a desired angle] (B) - (F) is obtained. In (B), an original picture (A) is rotated and an object image original picture with the angle surrounded with the thick frame is obtained. Although a slash part is a portion which is not in an original picture at this time, since an object image exists in an approximately center part, a problem is not produced. The original picture portion which overflows a thick frame is deleted.

[0009]In drawing 1, the object image by which image formation was carried out to the imagers 2, such as CCD, via the optical system 1 is changed into an electrical signal, and is inputted into the image pick-up process circuit 3. Well-known signal processing is performed to the signal from the imager 2, and the image pick-up process circuit 3 outputs a video signal to a recording system via the terminal 4a of the switch 4. The luminosity Y signal from the image pick-up process circuit 3 is changed into a digital signal by A/D converter 5, and is written in the field memory 6. From the speed signal generator circuit 10, while generating various synchronized signals, driving the trigger circuit 9, controlling operation of the imager 2 and controlling the operation timing of the image pick-up process circuit 3, the writing timing of the field memory 6 is controlled via the light control circuit 11. Under control of the address signal Add from the lead control circuit 15 from the field memory 6, After the video signal only turning around a predetermined angle is read so that it may mention later, and interpolation processing is performed with the interpolation coefficient K, it is changed into an analog signal by D/A converter 8, and is outputted to a recording system via the terminal 4b of the change-over switch 4. The microcomputer 12 sends out a control signal only for a predetermined angle to rotate the object image from the imager 2 to the lead control circuit 15.

[0010]A low-pass ingredient is extracted by the low pass filter 19, it integrates with the Y signal changed into the digital signal by A/D converter 5 by the integration circuit 20, and the acquired integral value is supplied to the microcomputer 12 as AE information. A high-frequency component is extracted by the band pass filter 13, and, as for the signal by which interpolation processing was carried out in the interpolation processing circuit 7, the integral value acquired in the integration circuit 14 is supplied to the microcomputer 12 as an evaluation value which shows the above-mentioned

focus degree to the microcomputer 12. The microcomputer 12 makes the focusing operation by the AF Motor Driver 17 drive based on this evaluation value perform via the processing mentioned later.

[0011]Drawing 3 is a figure for explaining the scanning direction detection principles for acquiring the suitable focusing evaluation value based on the information concerning the high-frequency component in one example of the automatic focus method by this invention. An object image (mountain which has the slanting ridgeline which made empty the background) as shown in the figure (A) is explained as an example. In this example, one screen is divided into the small block of 8x8, and the following processings are performed based on AE data obtained through a low pass filter and an integration circuit for every division section. About the picture shown in (A), since the ridgeline of a mountain is a slash when the direction which performs vertical bar detection like before is scanned, the output level of a band pass filter is low, as shown in (B), serves as dark space composition without contrast, and cannot acquire suitable focusing evaluation value.

[00012]In this example, AE information acquired by the low pass filter through the signal of each division section is detected. As shown in the figure (C), in the field equivalent to empty, the boundary part field of both fields becomes the luminosity which faded with the mean value low [the field equivalent to a mountain] (darkly) highly [a low pass filter output level] (bright). Therefore, based on AE information as shown in (C), the degree theta of angle of inclination of the ridgeline of the mountain to perpendicularly [as shown in (D)] is obtained. In this way, the rotating process later mentioned using the obtained degree theta of angle of inclination is performed, as shown in drawing 4, only theta can rotate an original image (dotted-line part), a rotational image like a solid line can be obtained, and focusing evaluation value suitable as vertical in the ridgeline of a mountain can be acquired.

[00013]The principle of the address translation for performing the roll control of the above-mentioned object image is explained with reference to drawing 5. Drawing 5 shows the address-position relation at the time of only theta rotating the original picture shown with a small-gage wire, and acquiring the thick line picture by an inclining scan. A white round head shows among a figure the real pixel memorized by the memory, and a black dot shows the virtual pixel read from a memory. Each address-position P (00), P (10), P (20), P (01), The picture element data corresponding to P (11), P (21), P (02), P (12), and P (22) is written in the field memory 6, It asks for corresponding address position Q (10) shown by the thick line after only theta rotates focusing on the position P (00), Q (20), Q (01), Q (11), Q (21), and — using the picture

element data of these address positions, and sends out to the field memory 6 as the address signal Add.

[0014]For example, the address-position Q(10) Q(20) Q(01) Q(11) virtual-pixel address in drawing 5 can be found as follows from the relation of a graphic display. Q. (10): x—P. (00) + costhetay—P. (00) +sinthetaQ. (20): x—P. (00) +2cos theta=P. (10) +2costheta-1 y—P. (00) +2sin theta=P. (— ten —) — +— two — sinthetaQ — (— 01 —) — : — x—P — (— 00 —) - sinthetay—P — (— 00 —) — + — costhetaQ — (— 11 —) — : — x—P — (— 00 —) - sin — theta+cos — theta=P — (— 01 —) - sin — theta+costhetay—P — (— 00 —) — + — cos — theta+sin — theta=P — (— 01 —) — + — cos — theta+sin — theta -one [0015]The example of a circuit which generates the above-mentioned X address is shown in drawing 6. In the pixel address and this example which are read first, 0 is set to the XST register 151X, XW=costheta shown in drawing 5 is generated from the XW register 152X, and X0=-sintheta shown in drawing 5 is generated from the X0 register 153X. 1 clock (1 pixel) delay of the output of the adding machine 154X is carried out with the delay device 156X. The adding machine 154X adds costheta from the XW register 152X, and the output from the delay device 156X. The output of the delay device 156X is added in the output (this example 0) from the XST register 151X, and the adding machine 158X. The delay device 157X is delayed only 1H in the output of the adding machine 155X. The adding machine 155X adds -sintheta from the X0 register 153X, and the output from the delay device 157X. The adding machine 159X adds the output of the delay device 157X, and the output of the adding machine 158X, and outputs them as a X address signal.

[0016]The example of a circuit which generates the Y address signal as drawing 6 with same drawing 7 is shown. Y0=costheta which 0 is set up, YW=sintheta shown in drawing 5 is generated from the YW register 152Y, and the YST register 151Y shows to drawing 5 from the Y0 register 153Y is generated. 1 clock (1 pixel) delay of the output of the adding machine 154Y is carried out with the delay device 156Y. The adding machine 154Y adds sintheta from the YW register 152Y, and the output from the delay device 156Y. The output of the delay device 156Y is outputted from the YST register 151Y (this example 0), and is added by the adding machine 158Y. The delay device 157Y is delayed only 1H in the output of the adding machine 155Y. The adding machine 155Y adds costheta from the Y0 register 153Y, and the output from the delay device 157Y. The adding machine 159Y adds the output of the delay device 157Y, and the output of the adding machine 158Y, and outputs them as a Y address signal.

[0017]The address translation figure at the time of rotating the address translation

principle figure shown in drawing 5 only 30 degrees by the case where it applies to the aspect ratio (768 pixels, 240 lines) of 3 to 4 shown in drawing 9 is shown in drawing 8. In this case, as shown in drawing 9, 1 pixel of every direction serves as a size of 2.4 to 1.

At this time, it is XST=0 XW=0.866 X0=-2.4x0.5YST=0 YW=0.5/2.4 Y0=0.866, and the general formula showing X address Xmn and the Y address Ymn in the pixel number m and line number n is as follows so that clearly also from a figure.

Xmn=XST+m-XW+n-X0Ymn=YST+m-YW+n-Y0 (coordinates), for example, the address of the 0th (n= 0) line. It becomes [(XY)= (0, 0) and / (0.866-0.208) (1.732, 0.417) --1 line] (XY)= (-1.2, 0.866), (-0.334-1.074), (0.532, 1.28), and -- (n= 1). Here, it is clear from a figure that the integer part of each address shows the address Add, and the decimal fraction shows the interpolation coefficient K.

[0018]Now, if drawing 1 is referred to, this example can respond also to electronic zooming operation when the zoom motor driver 16 is driven in response to operation of the zoom switch 18. Real pixel address P (00) shown in drawing 10 with a circle [white] at the time of electronic zooming operation, P (10), P (20), P (30), P (01), P (11), P (21), and P (31), Virtual pixel address [after zoom] Q (00), Q (10), Q (20), Q (30), Q (40), Q (01), Q (11), Q (21), Q (31), and Q (41) are shown. At this time, XW and Y0 are constant value and X0 and YW are 0.

[0019]The interpolation processing which extracts a high frequency component to high degree of accuracy more using the band pass filter in drawing 1 and which is performed for accumulating has a preferred four-point weighted average method as shown, for example in drawing 11. As shown in a figure, if X1 and X2 are defined, it will ask for address-position Q which should be read from a memory by a lower type using the weighted average of four point [of the circumference] P (11), P (21), P (12), and P (22).

Q=(1-Ky) X1+Ky-X2X1=(1-Kx) P(11)+KxP (21)

X2=(1-Kx)P(12)+KxP(22)

Therefore, Q=(1-Kx) (1-Ky) P(11)+Kx(1-Ky) P (21)

+ Ky(1-Kx) P(12)+Kx-Ky-P (22) -- (1)

(1) The operation of a formula is realizable by reading simultaneously 4-pixel address P (11), P (21), P (12), and P (22) in 1 cycle. Four above-mentioned pixels simultaneous read-out can be performed using a memory configuration as shown, for example in drawing 10.

[0020]In the example shown in drawing 12, four independent memories of an even number sequence, an even-line dedicated memory (A), an odd number sequence, an

even-line dedicated memory (B), an even number sequence, an odd-line dedicated memory (C) and an odd number sequence, and an odd-line dedicated memory (D) are provided so that 4 pixels can be once read by address supply.

[0021]In order that drawing 13 may perform the operation by the four above-mentioned weighted average circuit, the address generation circuit for data read from a memory is shown. The column address for odd number sequence memories, the column address for even number sequence memories, the line address for odd number row memories, and the line address for even number row memories are generated from 0-9 bits of column addresses, and 0-7 bits of line addresses. 0 bit of a column address is the adding machine 251, and is added with 1-9 bits while it is outputted as select signal HSEL. 1-9 bits becomes a column address for odd number sequence memories, and the output of the adding machine 251 serves as a column address for even number sequence memories. Similarly, 0 bit of a line address is the adding machine 252, and is added with 1-7 bits while it is outputted as select signal VSEL. 1-7 bits becomes a line address for odd number row memories, and the output of the adding machine 252 serves as a line address for even number row memories.

[0022]The example of a circuit for performing the four-point weighted average operation shown in (1) type using the lead data read from the memory is shown in drawing 14. In drawing 14, when select signal HSEL from which the selectors 253 and 254 were obtained by drawing 13 is "H", "H" terminal is chosen, the "L" terminal is chosen at the time of "L", and the terminal to which the selector 261 corresponds by select signal VSEL similarly is chosen. Even number sequence lead data of even lines and odd number sequence lead data of even lines are inputted into the selector 253, and even number sequence lead data of odd lines and odd number sequence lead data of odd lines are inputted into the selector 254. As for two outputs from the selector 253, the multiplication of a coefficient (1-Kx) and the Kx is carried out by the multiplier 255,256, respectively. The output of the multipliers 255 and 256 is added with the adding machine 257, and is outputted to two input terminals (L, H) of the selector 261. On the other hand, as for two outputs from the selector 254, the multiplication of a coefficient (1-Kx) and the Kx is carried out by the multiplier 258,259, respectively. The output of the multipliers 258 and 259 is added with the adding machine 260, and is outputted to other two input terminals (L, H) of the selector 261. Two outputs from the selector 261 are the above X1 and X2.

The multiplication of a coefficient (1-Kx) and the Kx is carried out by the multiplier 262,263, respectively.

The output of the multipliers 262 and 263 is added with the adding machine 264, and

the data Q after interpolation is obtained.

[0023]In the example of drawing 13 and drawing 14, it is because the address of four points which should be chosen is generated according to four kinds of pattern #1 - #4 as the thing which needs a select signal is shown in drawing 15, and this example shows the example of pattern #2.

[0024]

[Effect of the Invention]As explained above, according to the automatic focus method by this invention, even if it is an object image in what kind of inclination condition, always high-speed and highly precise controls focusing becomes possible.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a block diagram showing one example of the automatic focus method by this invention.

[Drawing 2]It is a figure for explaining the principle of the automatic focus method by this invention.

[Drawing 3]It is a scanning direction detection-principles figure for acquiring the suitable focusing evaluation value in the example of this invention.

[Drawing 4]In order to acquire suitable focusing evaluation value based on the scanning direction angle obtained by drawing 3, it is the figure made to rotate a picture signal.

[Drawing 5]It is an address-generation principle figure showing the image rotation principle in the example of this invention.

[Drawing 6]It is a circuit diagram for the principle figure shown in drawing 5 to generate an X address.

[Drawing 7]It is a circuit diagram for the principle figure shown in drawing 5 to generate Y address.

[Drawing 8]It is a figure showing the address-generation principle at the time of applying the principle shown in drawing 5 to actual image rotation.

[Drawing 9]It is a picture achieving figure used as the foundations of a principle figure shown in drawing 8.

[Drawing 10]It is a figure showing the principle of the electronic zooming operation in

the example of this invention.

[Drawing 11]It is a principle figure which performs interpolation processing in the interpolation processing circuit 7 in the example of this invention by a four-point weighted average operation.

[Drawing 12]It is a memory configuration figure used for performing interpolation processing shown in drawing 11.

[Drawing 13]It is a circuit diagram showing an example of the address generation circuit for memory read-out used by the interpolation processing shown in drawing 11.

[Drawing 14]It is a circuit diagram showing an example of the interpolation processing shown in drawing 11.

[Drawing 15]It is a figure showing ** of four points in the interpolation processing shown in drawing 11 chosen, and the example of ************.

[Drawing 16]It is a figure showing the object image of length, width, and slant.

[Drawing 17]It is a figure showing change of the high-frequency component acquired from the band pass filter in the conventional automatic focus method about each photographic subject shown in drawing 16.

[Description of Notations]

1 Optical system Two Imager

3 Image pick-up process circuit 4 change-over switches

5 A/D converter Six Field memory

7 Interpolation processing circuit 8 D/A converters

9 Trigger circuit 10 speed-signal-generator circuit

11 Light control circuit

12 Microcomputer 13 Band pass filter

14 and 20 An integration circuit and 15 Lead control circuit

16 Zoom motor driver

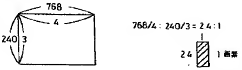
17 AF Motor Driver

18 Zoom switch

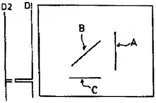
19 Low pass filter

DRAWINGS

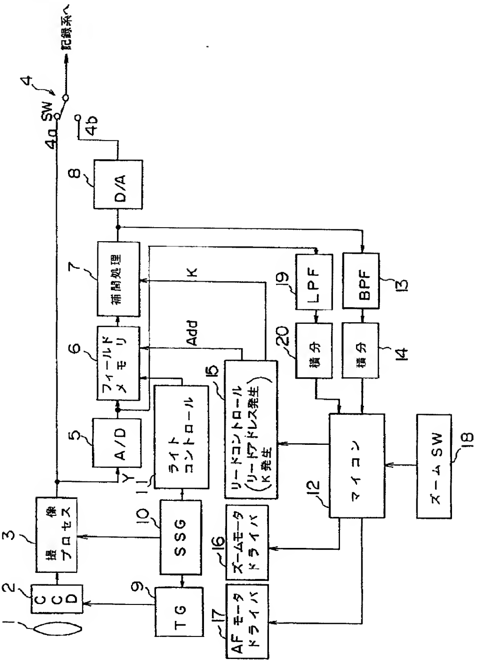
[Drawing 9]



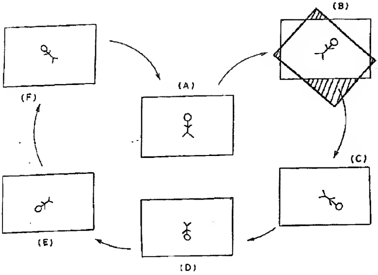
[Drawing 16]



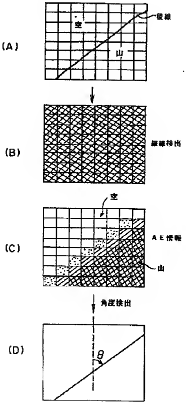
[Drawing 1]


SW
記録系へ
CCD
撮像プロセス
A/D
フィールドメモリ
補間処理
D/A
TG
SSG
ライトコントロール
リードコントロール
(リードアドレス発生 K発生)
Add
K
Y
LPF
BPF
積分
積分
マイコン
ズームSW
ズームモータドライバ
AFモータドライバ

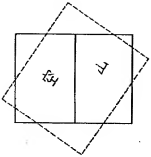
[Drawing 2]



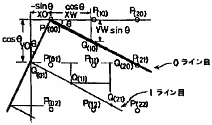
[Drawing 3]



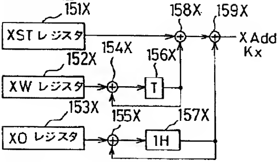
[Drawing 4]



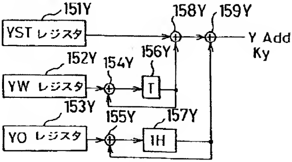
[Drawing 5]



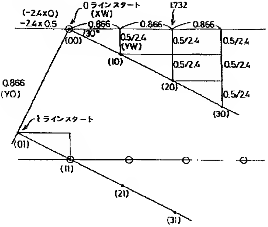
[Drawing 6]



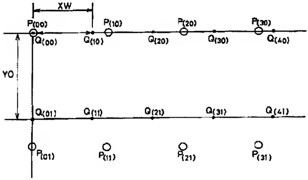
[Drawing 7]



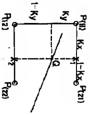
[Drawing 8]



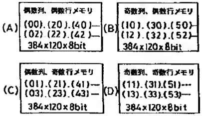
[Drawing 10]



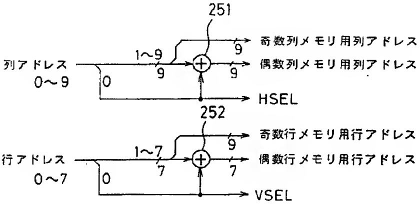
[Drawing 11]



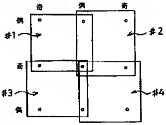
[Drawing 12]



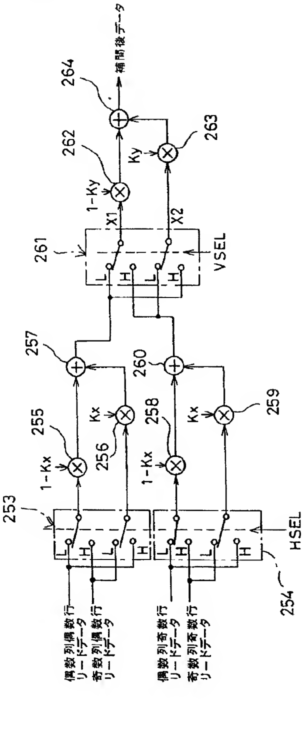
[Drawing 13]



[Drawing 15]



[Drawing 14]



偶数列偶数行リードデータ
奇数列偶数行リードデータ
偶数列奇数行リードデータ
奇数列奇数行リードデータ
253
254
255
256
257
258
259
260
261
262
263
264
1-Kx
Kx
1-Ky
Ky
X1
X2
HSEL
VSEL
補間後データ

[Drawing 17]